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little who makes the actual observations or whether observations are made or not. There can be little doubt that means exist for establishing schools of astronomy comparable with those which have arisen for other branches of science, and we sincerely hope that the need for serious attention to practical teaching in astronomy will soon be recognized.

So far as we know, there is only one institution in Great Britain where any attempt is made to give practical instruction in astronomical physics, and even in this case the greater part of the instruction is necessarily of a somewhat elementary character, in consequence of the small amount of time available for the subject.

It is a natural consequence of our inadequate provision for technical education in astronomy — more particularly in the newer branches — that vacancies in our observatories must be filled by observers who have still to make practical acquaintance with the work expected of them. Much loss of time and apparent inactivity is the result.

It may be urged that benefactors of the science of astronomy are less numerous here than in America, but the generous gifts of Dr. F. McCLEAN to Cambridge University and the Cape Observatory, and of Sir HENRY THOMPSON to the Royal Observatory, Greenwich, remind us that they are not wholly wanting. Besides, there are already numerous observatories scattered throughout the country which might be made more productive by putting them in the hands of observers who have received adequate training. Public interest in astronomy is by no means absent, and British observatories would, perhaps, receive a much increased measure of support if it were not for the possible impression that the best work can only be done in America, and that instruments of the largest size are alone useful.

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A HANDBOOK OF ASTRONOMICAL INSTRUMENTS.

*Handbuch der Astronomischen Instrumentenkunde. Von Dr. L. AMBRONN, Professor an der Universität und Observator an der königl. Sternwarte zu Göttingen. Mit 1185 in den Text gedruckten Figuren. Berlin, Verlag von JULIUS SPRINGER, 1899. (Price, \$15.00.)*

Dr. AMBRONN's two large volumes form an encyclopædia of astronomical instruments in which the whole of the instrument-

maker's art, from the shaping of the slot in a screw-head to the construction of a modern great equatorial, is clearly described and illustrated with an abundance of excellent figures. The work is not wholly descriptive, however, since theoretical discussions of many subjects, such as the determination of the periodic errors of screws and of the graduation errors of circles, are freely introduced.

The first volume, containing five hundred pages, is devoted to accessory apparatus, clocks, and the separate parts of instruments. We find here an account of screws, levels, artificial horizons, axes and circles, mirrors, eye-pieces, etc. An interesting feature of the book is that the descriptions are not confined to instruments of the present day. Older forms of instruments, progenitors of modern types, are treated at some length, and illustrated when the historical development of the subject makes their consideration desirable. Thus we find, in the first volume, an account of various early applications of the plumb-line and of early forms of clocks.

The second volume, containing 776 pages, is devoted to complete instruments of every kind—meridian-circles, universal instruments, chronographs, equatorials, etc., but it is impossible to give here an adequate idea of the contents of this very complete treatise.

Dr. AMBRONN'S volumes are, on the whole, a manual of German practice; but national bias in such a work is inevitable, and in this case is the less to be regretted, since the Germans have always excelled in the art of instrument-making. Still, readers of other nationalities will notice omissions which they may be inclined to regard as important. No American, perhaps no Englishman, would write a treatise on screws in which ROWLAND'S method of making screws of precision, as described in the *Encyclopædia Britannica*, is not mentioned. In the chapter on clocks the name of DENT does not occur. Sir E. BECKETT'S gravity escapement, which is so widely used in England and America, and which is probably the best of its kind, is not described or even referred to. On the other hand, an English or American writer would certainly overlook many of the escapements described and illustrated in the same chapter, as they are hardly used outside of Germany.

On reading the author's comments on different forms of instruments, in which complicated devices for manipulation or adjust-

ment are almost invariably spoken of in terms of approbation, one cannot avoid the impression that simplicity and rudeness are too generally regarded as synonymous, while elaborateness is regarded as essential to the highest precision. This attitude is noticeable in the comments on American instruments, of which, it seems to the reviewer, the author has failed to grasp the characteristic features. These are, briefly, the care bestowed on essentials, and the indifference with which minor details are treated. One can imagine the disfavor with which the author would view the rough-looking yet effective instruments of the Harvard College Observatory. The lover of instruments may like to see his apparatus beautiful and perfectly finished in all its parts, but he should be willing to concede that perfection of finish is not essential to performance. There are some instrument-makers, like the late Mr. DENT, the celebrated English clock-maker, who finish the non-essential parts of their instruments with the greatest care, in deference to the wishes of their patrons, though personally holding the opinion that in so doing they are merely wasting time. In America the rough-looking instrument is not generally objected to, if its proportions are correct, and if it works well.

Appliances for the adjustment and manipulation of instruments do not always tend to increase the accuracy of observation, and sometimes are even prejudicial to it. For instance, the clamp and tangent-screw ordinarily attached to graduated circles are not used by skilled observers with the micrometer. The elaborate mechanical adjustments on some forms of level-tries are, possibly, conveniences, but they do not (as is implied by the remarks on p. 62) add anything to the precision of the observations. The essential feature of this instrument is stability, including freedom from the effect of temperature changes.

It is true that (as stated on p. 1049) the Americans have not advanced beyond the single-pen form of chronograph. Their preference for this form does not, however, arise from prejudice or non-progressiveness, but from the consideration that even with a single pen the record is still more precise than the observation itself. The use of a double set of prickers, by which the record of an observation can be read to a few thousandths of a second, would seem to be as unnecessary as seven-place logarithms for computing the time of sunrise.

If the details of many American instruments might be more carefully fitted and finished, it may be said of many German

instruments that the harmony of the general design has been to some extent lost sight of in the attention paid to the component parts. The weight of metal is often in the wrong place, and the instrument has an awkward appearance. An exception should be made here of the graceful instruments of REPSOLD. In the judgment of the reviewer, there is no small equatorial among the many illustrated in Dr. AMBRONN'S book which so fully satisfies the sense of mechanical proportion as the WARNER & SWASEY mounting on page 1156.

The mounting of a modern great equatorial is really a problem in engineering, and if one may venture a criticism of the fine large equatorials of recent European construction, it is that they have been treated rather from the standpoint of the instrument-maker. With respect to the numerous attachments of large equatorials, it is certain that, in the case of the Lick telescope, at least, experience has shown some of them to be unnecessary; and this is a point of no small importance, since these attachments are often very expensive. The quick motions for operating the Lick telescope from the top of the pier are indispensable, but the slow motions at the same place are never used, and, since they somewhat increase the friction of the polar axis, they could well be dispensed with. The microscope and reflectors for reading the finely divided hour-circle from the eye-end have never once been used, and the declination microscopes at the eye-end very seldom, so that these attachments have been removed. In fact, on duly considering the matter, we find that the fine circles of a great equatorial have only one use — to perfect the adjustment of the polar axis,—and provision for reading them from the head of the pier is sufficient for this, and therefore for every purpose.

By far the least satisfactory chapter in the book is the one on spectroscopic apparatus, which is compiled, not very judiciously, from various sources. The instruments and appliances to which the greater part of the space is devoted are old and of small efficiency, while really efficient instruments, for which all the conditions of use have been carefully studied, are passed over lightly, or only referred to in foot-notes. It is true that the former instruments might have been introduced for their historical interest, but the reader is left to suppose that they are still valuable for purposes of research. The Potsdam spectrograph, which has only recently been superseded by more efficient instruments, has about a page. It is a pity that the MILLS spec-

trograph of the Lick Observatory, Professor VOGEL's new Potsdam spectrograph, or Dr. GILL's spectrograph for the Cape Observatory, could not have been included; but for this the book was published just a little too soon.

A brief statement of the theory of resolving power, as developed by Lord RAYLEIGH, would have been very useful as a guiding principle, which is totally lacking in the chapter, and would have shown at once the practical uselessness of some of the forms of spectroscopes described.

The chapter on photometers, on the other hand, is especially valuable. Here the different forms of photometers used in astrophysical research are brought together in a most convenient form for reference.

Occasional mistakes can be found. Fig. 1160, which purports to represent the moving floor of the Lick Observatory, is a design which was proposed, but not adopted; but such mistakes as this would naturally be made by one who is not personally familiar with all the instruments described, and they are few in number. It is hardly necessary to say that Dr. AMBRONN's valuable book should be found in the library of every observatory.

J. E. KEELER.

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PLANETARY PHENOMENA FOR JULY AND AUGUST,  
1900.

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BY MALCOLM McNEILL.

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JULY.

The Earth is in aphelion at 4 A. M., July 2d, P. S. T.

*Mercury* is an evening star throughout the month, and comes to greatest east elongation on the morning of July 4th. During the first half of the month it will set an hour or more after sunset. After the middle of the month, it will be too close to the Sun to be seen, and it reaches conjunction with the Sun on the night of July 31st-August 1st. The present elongation,  $26^{\circ}$ , is greater than that in March, by  $8^{\circ}$ , as it comes very near the time when the planet is in aphelion, July 13th, while that in March was about the same interval from perihelion. The fact that at the July elongation the planet is south of the Sun, while the reverse was true in March, makes a considerable offset in the